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Ministry of the ENVIRONMENT

Environmental Quality of Peninsula Harbour Lake Superior

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ENVIRONMENTAL QUALITY

OF

PENINSULA HARBOUR

LAKE SUPERIOR

ONTARIO MINISTRY OF THE ENVIRONMENT

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INTRODUCTION

This report presents the findings of studies of the environmental effects of municipal and industrial wastes being discharged into Peninsula Harbour area of Lake Superior. The harbour is located approximately 200 miles east of Thunder Bay on the north shore of Lake Superior. Wastewaters are discharged from the bleached kraft pulp mill and the chlor-alkali plant of the American Can of Canada Limited and the primary sewage treatment plant of the Township of Marathon.

The studies were conducted by the Biology and Water Quality Surveys Branch of the OWRC* at the request of the OWRC Divisions of Industrial Wastes and Sanitary Engineering. The information obtained from these studies will be used by the respective divisions in their on-going pollution abatement programs in the province.

Biological studies were conducted in July 1969 and included an examination of standing crops of bottom fauna in the harbour and adjacent area of Lake Superior. Surveys of the mill and water quality including zones of influence of the waste discharges were continued in September 1970. Because of possible hazards to human health from the consumption of mercury contaminated fish, the 1970 surveys included an examination of the mercury losses from the American Can Complex and the contamination by mercurial compounds of lake bottom sediments in the Marathon vicinity.

Following a description of the water quality and biological conditions, a set of preliminary water quality standards are presented for inshore and open waters of Lake Superior.

* Now Ontario Ministry of the Environment

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The aquatic environments of Peninsula Harbour and part of Lake Superior adjacent to the Peninsula have been adversely affected by the wastewater discharges from the Marathon mill of the American Can of Canada Limited and the effluent from the primary treatment plant (0.25 MIGD capacity) serving the Township of Marathon. The industrial wastewater discharge (approximately 25 MIGD) was by far the larger source of contamination. The main effects included changes in water quality, particularly bacteriological contamination, aesthetic impairment, accumulation of mercury in fish and bottom sediments, and organic enrichment of bottom sediments. The latter was also reflected by the presence of high standing crops of pollution tolerant sludge worms. However, no accompanying disruption in the range, variety or abundance of other indigenous bottom fauna was detected.

Because of the importance of Lake Superior as the largest supply of fresh water in North America and which to date still remains relatively unaffected by man's activities except on a localized basis, every effort should be made to protect the water quality from degradation that has already occurred in the lower Great Lakes. It is expected that a stringent non-degradation policy for Lake Superior will be established in the near future by Canadian and United States authorities. This would imply that all wastes would have to undergo the best treatment practicable including nutrient removal prior to discharge to the lake.

In an effort to alleviate the existing impairment in Peninsula Harbour as well as to reduce the input of polluting substances which on a long-term basis could contribute to a large scale degradation of water quality of Lake Superior, it is recommended that:

1. The American Can of Canada Limited take the necessary control measures to:

   a)* ensure that the suspended solids levels of the wastewater discharges are maintained consistently within the existing 50 mg/l requirement of the OWRC.

   b) eliminate foam from the surface of Lake Superior in the vicinity of the present outfall.

c) effect more rapid dispersion of the colour associated with the mill discharges to Lake Superior using a submerged diffuser outfall or other suitable discharge methods.

d) reduce phenolic substances from the mill wastes.

e)** ensure that mercury losses from the chlor-alkali plant are kept to a minimum.

f) segregate the sanitary wastes from process wastes and either provide suitable treatment or discharge them to the municipal system for treatment.

2. The Township of Marathon expand its sewage treatment facility to provide adequate treatment including disinfection of effluent for existing and future municipal wastewaters.

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* The American Can of Canada Limited installed a mechanical clarifier which was started up in February 1972. It is expected that the 50 mg/l requirement for suspended solids will be met consistently now that the unit is in operation.

** In addition to the extensive control measures already taken, the Company is presently installing external treatment facilities for the further removal of mercury. Once completed, the mercury losses from this plant should be minimal.

1. DESCRIPTION OF STUDY AREA

1.1 General

Peninsula Harbour is located approximately 200 miles east of Thunder Bay on the north shore of Lake Superior. The study area consisted of essentially two regions, Peninsula Harbour and portion of Lake Superior immediately adjacent to the south side of the Peninsula.

Peninsula Harbour contains numerous small bays and is separated and sheltered from the open waters of Lake Superior by two islands on the west side and peninsulas on the north and south sides. The southernmost peninsula (named the Peninsula), reaches out over a distance of approximately three-quarters of a mile in a north-westerly direction toward the open water of Lake Superior.

The main population centre in the area is the Township of Marathon (population 2,452) which is located at the base of the Peninsula. The townsite (Marathon) extends from the south shore of Jellicoe Cove, one of the bays in the inner harbour, across the neck of the peninsula to the shore of Lake Superior. The main industry in the town is the bleached kraft pulp mill owned and operated by the American Can of Canada Limited. In conjunction with the pulp mill, this company also operates a chlor-alkali plant which produces principally caustic soda and chlorine. The industrial operations are located on the south shore of Jellicoe Cove.

The locations of the industrial complex and Township of Marathon are shown in Figure 1.

1.2 Water Uses

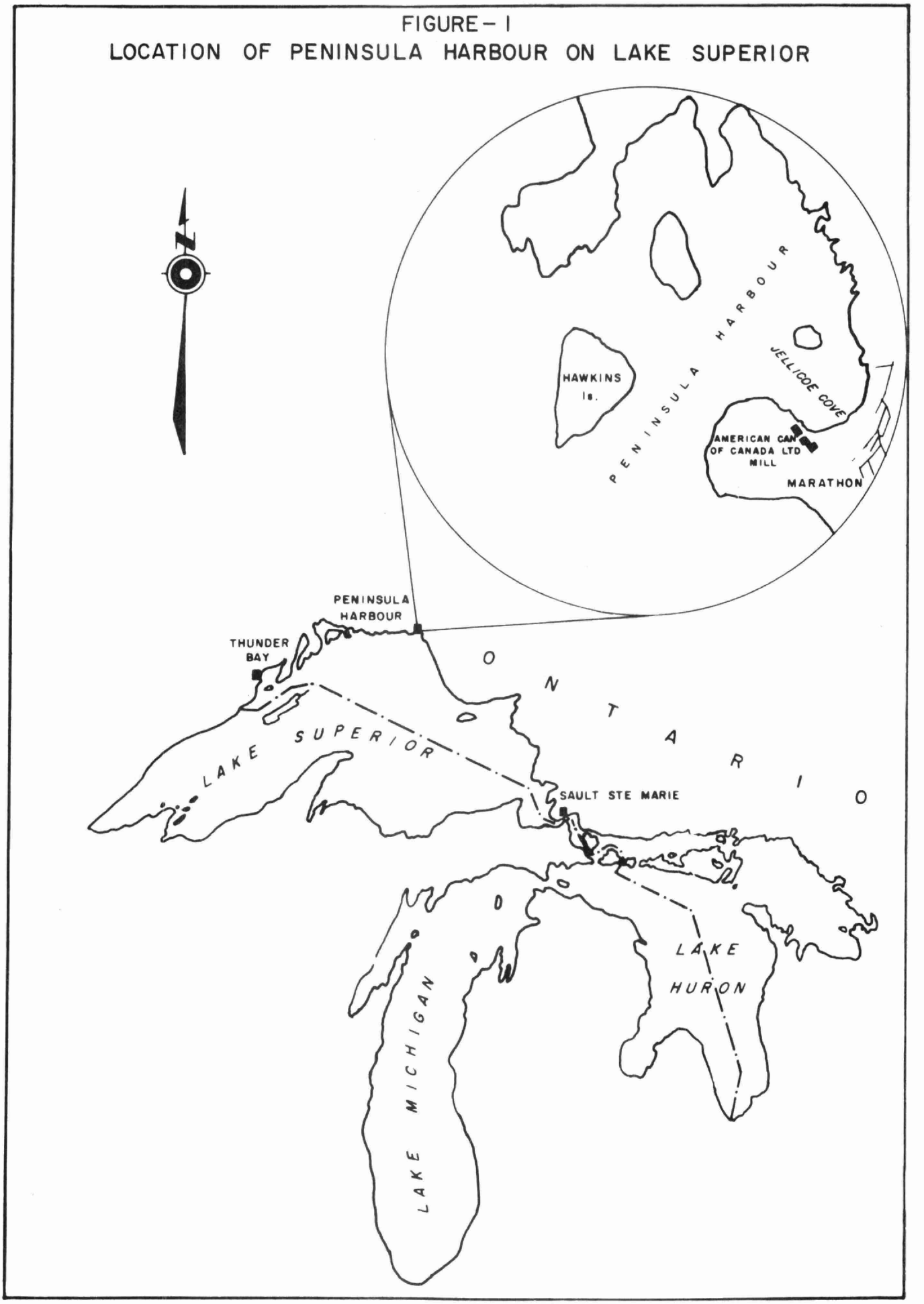
The waters of Peninsula Harbour are used mainly for supply of process water and disposal of mill wastes by the American Can of Canada Limited operation. This industry withdraws approximately 25 MIGD of water from the Jellicoe Cove area for the production of about 500 tons/day of bleached kraft pulp and for use in the chlor-alkali plant. The chlor-alkali plant produces chlorine, caustic soda, sodium hypochlorite, sodium chlorate and hydrochloric acid. The wastewater discharges from the mill complex amount to approximately the same volume. Sections of the harbour are also used by the industry for the storage of logs.

The Township of Marathon discharges approximately 0.30 MIGD of effluent from its primary degree sewage treatment plant to Lake Superior on the south side of the Peninsula. Water supply for the township is obtained from three wells in the area.

There is no extensive commercial fishing in Peninsula Harbour in the vicinity of Marathon.

FIGURE – I

LOCATION OF PENINSULA HARBOUR ON LAKE SUPERIOR



2. SURVEY OUTLINE

2.1 Mill Survey

Wastes from the pulp mill and the chlor-alkali plant are discharged to Peninsula Harbour through six outfalls which are described in Appendix A. Locations of the outfalls are shown in Figure A.1. Two of these, the main mill sewer and the No. 1 bleachery filtrate are pumped to Lake Superior while the remaining four outfalls discharge to Jellicoe Cove area of Peninsula Harbour. The discharges to Lake Superior which normally account for about 90 percent of the total wastewater volume amounted to about 80 percent of the total volume during the 1970 survey.

All outfalls were sampled during the daytime period on September 2 and 3, 1970 to obtain qualitative and quantitative information on the mill wastes. Details of the sampling procedures and analytical results are given in Appendices A and B, respectively.

2.2 Environmental Surveys

Water samples for chemical and bacteriological analyses were collected on September 2 and 3, 1970 in Lake Superior to define the nature and extent of water quality impairment caused by the mill wastes. Similarly, sediment samples were collected to determine the levels of mercury and organic matter in the sediments. Most of the sediment sampling was concentrated in the Jellicoe Cove where the wastewaters from the chlor-alkali plant are discharged. Details on the methods used for collection of sediment samples, a map showing locations of all sampling stations, and analytical results for both water quality and sediments are presented in Appendices A and B.

The biological study which was carried out from July 14 to 25, 1969 included an examination of standing crops of bottom fauna in both Peninsula Harbour and Lake Superior.

The biological survey methods, listing of all taxa and numbers of bottom fauna found at each sampling location as well as a map showing the sampling locations are presented in Appendices A and B, respectively.

3. FINDINGS AND DISCUSSION

3.1 Mill Survey - Waste Sources

The wastewater discharges from the kraft pulp mill of the American Can of Canada Limited at Marathon provides the main input of wastes into the waters of Peninsula Harbour and immediately adjacent area of Lake Superior. During the 1970 mill survey, the total volume of wastewater discharges amounted to approximately 25 MIGD (Table B.1) which is slightly higher than those measured during earlier studies (Table B.2). The 1970 organic wastewater loading of 74,000 lbs BOD_5 per day, although comparable to three of the five loadings obtained during mill surveys between the years 1966 and 1970, was almost twice as high as the normal loading of 40-45,000 lbs BOD_5 per day associated with this mill. The latter loading is consistent with average year round operations as opposed to the short term sampling associated with OWRC surveys.

The suspended solids levels in the main mill sewer were lower than 50 mg/l at the time of this study. During earlier surveys, the levels have fluctuated widely; the average for the last five annual surveys being 105 mg/l. The present OWRC requirement of 50 mg/l of suspended solids has not been met consistently. The suspended solids levels in the discharge from the barking operations ranged from 80 to 320 mg/l. During earlier mill surveys, these have also exhibited wide variations but have not met the 50 mg/l requirement. The company completed installation of a mechanical clarifier in February 1972. It is expected that once this unit is in full operation, the 50 mg/l requirement for suspended solids will be met consistently.

The total input of phosphorus (total) from the mill amounted to about 70 lbs of which approximately 15 lbs was contained in the discharges into Peninsula Harbour and the remainder going to Lake Superior.

Another significant pollutant associated with the operations of American Can complex has been the loss of mercury from the chlor-alkali plant. On September 2, 1970, the total loss of mercury from this mill was approximately 6 lbs/day. This loading is based on one set of samples and may therefore not be representative of the average daily loss of mercury which has varied from 0.5 to 2 lbs per day during 1970. Later in 1970, in-plant remedial measures reduced the mercury losses significantly. For example, subsequent investigations in December 1970 and January 1971 showed mercury discharges of 0.48 and 0.44 lbs/day, respectively. The high concentrations of mercury found in the bottom sediments of Jellicoe Cove are believed to be attributable to earlier plant operations prior to corrective actions taken in 1970. The company is also installing external treatment facilities which are expected to reduce the loss of mercury to a minimum.

The primary sewage treatment plant of the Township of Marathon discharges approximately 0.30 MIGD of the treated wastewaters into Lake Superior. The plant is rated at 0.25 MIGD and is therefore hydraulically overloaded. The organic wastewater loading which averaged approximately 270 lbs BOD_5 per day during 1970 is relatively small in comparison to the industrial loading. The discharge of phosphorus (total) from the sewage treatment plant was about 20 lbs/day and accounted for about 27 percent of the combined municipal and industrial phosphorus discharges into Lake Superior.

3.2 Water Quality

The natural background surface water in Peninsula Harbour and in Lake Superior is of excellent quality; however, localized impairment has been caused by the wastewater discharges from the American Can of Canada Limited operation at Marathon. The degree and extent of the water quality impairment is highly variable depending on the dispersion and mixing of the mill discharges with waters on the Lake Superior side of the Peninsula. Since the mill effluent is warmer and therefore less dense than the lake water, it forms a thin plume on top of the cooler lake water. The shape and dispersion of the plume is strongly governed by wind direction. For example, on September 2, 1970, south-easterly winds pushed the plume close to shore and around the Peninsula into the Peninsula Harbour area. The dark brown colour of the effluent accompanied by floating foam was visible in the harbour as far as one-half mile from the northern shores of the Peninsula. Two days later, strong offshore winds pushed the plume out towards the open waters of the lake. It was visible for more than 5,000 feet from the outfall while the inner harbour waters had cleared.

3.2.1 Water Chemistry

In general, the impairment of water quality in Peninsula Harbour was restricted to the immediate vicinity of the outfalls in the Jellicoe Cove area (Tables B.3 and B.4). On Lake Superior side of the Peninsula, the degradation was more pronounced and extensive because of the larger waste input. However, as mentioned in the preceding section, the water quality in the area, particularly on the Lake Superior side of the Peninsula, is governed by the dispersion of the plume formed by the discharges from the mill.

The main changes in water chemistry included increases in the concentrations of dissolved and suspended solids, nutrients, BOD_5, COD, and phenolic substances. In general, the most significant changes in the concentrations of these parameters were restricted to the vicinity of the outfalls. For example, the dissolved solids concentrations ranged from 75 to 175 mg/l

within a 500 ft. range of both the main sump overflow and the discharge from the barking operation in Jellicoe Cove. Suspended solids in this area were generally around 5 mg/l with the exception of one sample near the main sump overflow which showed a suspended solids level of 40 mg/l. The high level probably occurred when the sump was overflowing. Elsewhere in the harbour, the dissolved solids ranged between 60 and 80 mg/l.

The dissolved solids levels in the surface waters of Lake Superior adjacent to the Peninsula generally ranged from 190 to 340 mg/l within a 1,000 ft range of the main discharge from the mill. Suspended solids in this area ranged from 5 to 50 mg/l. The elevated levels were restricted to the surface layer only and the water quality below the top layer and beyond the edge of the plume was not impaired significantly.

The nutrient levels showed an approximate 25 percent increase over background concentrations of total nitrogen and an approximate 100 to 200 percent increase over background concentrations of phosphorus within a 1,000 to 2,000 ft range of the outfalls in both Peninsula Harbour and Lake Superior. The total phosphorus concentration in the Jellicoe Cove area ranged from 0.025 mg/l at 500 ft from the main sump overflow to 0.015 mg/l at 2,000 ft from the outfall. Beyond this distance, the levels generally decreased to less than 0.01 mg/l. The phosphorus levels in Lake Superior followed a similar pattern although, as mentioned earlier, the concentrations in this area would be influenced by the location of the plume.

The BOD_5 and COD levels in the harbour were generally below 2 and 15 mg/l, respectively. On Lake Superior side of the Peninsula, the BOD_5 concentrations in the surface waters varied from a high of 125 mg/l near the outfall to <1 mg/l at 2,000 ft from the outfall. The corresponding COD levels were 190 mg/l and <10 mg/l. Beneath the layer of dark coloured surface water in this area, the BOD_5 and COD levels were generally below 1 and 10 mg/l, respectively. At the time of this survey, the dissolved oxygen levels in the surface waters in the vicinity of the main discharge from the mill ranged from a low of 67 percent saturation (6.2 mg/l) near the immediate vicinity of the outfall to approximately 80 percent saturation (7.6 mg/l) at a distance of 2,000 ft from the outfall. Farther out the levels increased to near saturation.

The phenolic substances concentration in the harbour ranged from a high of 29 ug/l in the immediate vicinity of the outfalls to <10 ug/l at distances beyond 1,000 ft from the outfalls. In Lake Superior, the phenolic substances ranged from 250 ug/l near the mill discharge to less than 5 ug/l at 2,000 ft from the outfall. The OWRC criteria for phenolic substances for public

water supplies is 1 µg/l. Phenolic substances are also believed to partly contribute to tainting of fish.

Changes in other water quality characteristics such as conductivity, colour and turbidity followed similar patterns.

Analyses of water samples collected from the vicinity of the outfall did not reveal presence of mercury.

3.2.2 Bacteriological Quality

The bacteriological criteria used by the Ministry of the Environment for assessing the acceptability of surface waters for specific uses are taken from the OWRC publication "Guidelines and Criteria for Water Quality Management in Ontario". In this publication the criteria for raw water supplies and for swimming and bathing areas are defined as a geometric mean based upon at least four samples per month (one sample for each week of the month) and upon at least ten samples per month (including samples collected during weekend periods), respectively. For a raw water supply, the geometric mean levels considered acceptable are 5,000 coliform organisms per 100 ml, 500 fecal coliform organisms per 100 ml and 50 fecal streptococci organisms per 100 ml. For swimming and bathing, the geometric mean levels considered acceptable are 1,000 coliform organisms per 100 ml, 100 fecal coliform organisms per 100 ml, and 20 enterococcus (fecal streptococci) organisms per 100 ml. These levels are presented for comparison with the data collected during the survey. When making this comparison, it must be acknowledged that during the period of survey, it was not possible to collect sufficient bacteriological samples to meet the geometric mean requirements of the above criteria. However, the following comparisons with the criteria provide an indication of the relative magnitude of bacteriological water quality problems.

High total coliform counts were found in Jellicoe Cove within a 2,000 ft range of the main sump overflow. Two out of ten coliform determinations made in this area exceeded 5,000 coliforms per 100 ml and seven exceeded 1,000 coliforms per 100 ml.

Fecal streptococci densities of 572, 260, 134 and 100 organisms per 100 ml were found at stations 1, 4, 7 and 25, respectively, in Jellicoe Cove. Out of a total of ten determinations, the previously mentioned four exceeded 50 organisms per 100 ml and eight were above 20 organisms per 100 ml. These organism densities reflect the influences of the wastewaters from the main sump overflow.

Fecal coliforms were highest in Jellicoe Cove but the levels did not exceed 100 organisms per 100 ml.

On the Lake Superior side of the Peninsula, the bacteriological quality of waters within 250 ft of the main mill outfall failed to meet the criteria previously described for raw water supplies and for swimming and bathing. The bacterial counts were high within this limited area; for example, samples taken at stations 35, 37 and 39 (Figure A.1) had fecal coliform counts of 11,700, 9,800 and 14,600 organisms per 100 ml and fecal streptococci counts of 810, 920 and 540 organisms per 100 ml, respectively. Bacterial contamination on this side of the Peninsula is due to both municipal and industrial wastewater discharges and it is recommended that efforts should be made to alleviate this problem. Beyond the 250 ft radius, the bacteriological quality improved considerably. However, it should be noted that the bacteriological samples from this area were collected when onshore winds prevailed. It is probable that bacteriological contamination during periods of offshore winds would extend further into the open waters of Lake Superior.

3.2.3 Bottom Sediments

The mercury content of sediment samples collected from Peninsula Harbour during the water quality survey, was generally high, especially for those samples taken from Jellicoe Cove near the main mill sump overflow. High concentrations were, as a rule, restricted to the top six inches of sample. Results for the sediments are presented in Table B.5. Average mercury concentrations of 14, 44 and 13 mg/kg were found in the top three inches of sediment at distances of 250, 500 and 1,000 ft, respectively from the main effluent sump overflow.

3.3 Biological Evaluation

In this study, bottom fauna communities were the only parameter investigated. The locations of sampling stations are shown on Figure A.2. The term bottom fauna refers to animal life visible to the unaided eye, which live either in or on the sediments at the bottom of the lake. Because of the differentially responsive and immobile nature of benthic species, as well as their importance as a source of fish food, this group of animals constitutes the most useful segment of the biota for making an accurate assessment of water quality. The degree of upset of the community balance associated with water quality alteration provides a good indication of the nature and degree of impairment, as well as direct evidence of an effect on the aquatic life of the receiving water.

3.3.1 Bottom Fauna

A complete listing of the taxa and numbers of bottom fauna found at each sampling site are presented in Table B.6.

Eleven taxa of bottom fauna were identified from the samples collected. The amphipods *Pontoporeia affinis* were the most frequently encountered organisms, followed closely in distribution and abundance by tubificid worms and midge larvae. The isopods *Asellus militaris*, amphipods *Gammarus* and fingernail clams *Pisidium* were also present in significant numbers within Peninsula Harbour. These organisms were not common at the open water stations on Lake Superior. Distribution of the remaining taxa was too sporadic to be of significance in the interpretation of water quality.

a) Peninsula Harbour

The amphipod *Pontoporeia affinis* was found at all stations except F1 and F2 in the harbour. Densities of these organisms showed no relationship with distance from the source of wastes. A definite relationship was noted, however, between depth of water at the sampling site and the number of amphipods secured. This relationship is evident in the Table below:

Depth - Density Relationship of *Pontoporeia affinis* in Peninsula Harbour

No. of *Pontoporeia affinis*	No. of Samples	Average Station Depth (feet)
10	16	24
11 to 20	15	32
21 to 50	7	44
51 to 100	13	73
100	10	111

In contrast to *P. affinis*, densities of sludgeworms in Peninsula Harbour showed no correlation with depth but a positive relationship existed between numbers of sludgeworms and proximity of the sample site to the main mill sump overflow. Greatest numbers of these organisms were found at stations G and H, between the Peninsula and Skin Island.

Midge larvae were common in consistently moderate numbers at all stations. No particular response to pollution was evident from their distribution or density.

The amphipods *Gammarus*, fingernail clams *Pisidium* and isopods *Asellus militaris* exhibited a scattered distribution throughout Peninsula Harbour. *Asellus militaris* was most abundant in samples containing bark wastes.

b) Lake Superior

As in Peninsula Harbour, numbers of amphipods *P. affinis*, showed a strong relationship with depth at the Q, R and S stations. At these same stations, however, sludgeworms *Oligochaeta* increased in numbers with increasing distance away from the main mill discharge. The absence or near absence of sludgeworms at Stations R1 to R3 and S1 to S3 probably reflects a truly toxic environment since these stations were located within the zone of discolouration extending outward from the main mill discharge. High numbers of sludgeworms at Station Q3 to Q6, R4 to R6 and S4 to S6 provide a positive indication of organic enrichment associated with the main discharge.

The significance of bottom fauna communities at Stations T, U, V and W in Lake Superior is far more difficult to interpret. Numbers of *P. affinis* were consistently low and bore no relationship with depth. Other fauna, including sludgeworms, were poorly represented at all of these stations.

Toxic pollution, substrate characteristics and wave and current action are all possible contributing causes for the impoverished nature of the bottom fauna communities in this portion of the lake. Undoubtedly, the scouring action of waves is a significant factor. Smoothly polished boulders and rock outcrops are common all along the shoreline from the Peninsula to Randle Point. Wave action, however, would not explain the low standing crop of amphipods in 220 feet of water at station T6 or at the other deep water stations.

While no special attempt was made to determine the specific impact of nutrient materials discharged to Lake Superior from the Marathon area, the influence of nutrient inputs was evident to a distance of approximately two miles southeast of the Peninsula. Submerged rocks along this shoreline supported profuse growths of the algae *Cladophora*, a positive indication of nutrient enrichment.

3.3.2 Mercury Contamination of Fish

Fish are noted for their ability to concentrate heavy metals such as mercury. The accumulated heavy metals, while possibly not affecting the fish, can be hazardous to human health if consumed in sufficient quantities.

An assessment of the available data indicates serious, but localized contamination of fish flesh. These results are provided in Table B.7. All four lake trout and two of the white-fish that were analyzed contained mercury levels which exceed the

level of 0.5 mg/kg considered to be safe for human consumption. These fish were all captured in the immediate vicinity of Marathon. Species analyzed from adjacent bays showed generally low levels.

4. WATER QUALITY CONTROL

The waters of Lake Superior to date have been relatively unaffected by pollution except on a localized basis in inshore areas. This has been due more to the lack of development around the lake than to any concern for its ecostructure. However, continuing growth and development will exert increasing pollution pressures on this system. Therefore, comprehensive water quality management programs including stringent water quality standards should be established to protect this valuable resource from the degradation that has occurred in the lower Great Lakes.

4.1 Water Quality Standards

In the case of Peninsula Harbour, the water quality impairment is now restricted to a relatively small inshore area of the lake. However, the continuing discharge on a long-term basis of nutrient materials such as organic carbon, nitrogen and phosphorus can contribute to the degradation of the offshore waters of the Lake Superior. In addition, the effects of tainting compounds (e.g. phenolic substance) and toxic metals (e.g. mercury) may be felt on a wider basis due to the mobility of fish populations.

Control of the various pollutants for long-term protection should, therefore, be given high priority in water quality management programs for the lake. For example, although the organic wastewater discharges (BOD_5) did not appear to have significant effects on the dissolved oxygen levels in the area, these wastes should be controlled to avoid the risk of a build-up of carbonaceous materials on a long-term basis.

At this time the Canadian and U.S. authorities have not finalized standards for the open waters of Lake Superior but a non-degradation policy with stringent water quality standards is being discussed and probably will be established in conjunction with the upcoming IJC study of the Upper Great Lakes. Water quality criteria have already been suggested by the Lake Superior Water Quality Technical Committee *(1)*. Interim standards compatible with these criteria are presented in Table 4.1 for sections of Peninsula Harbour and Lake Superior in the vicinity of Marathon. Sub-section

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(1) Meeting on May 28, 1970 - representatives of FWQA, Michigan Water Resources Commission, Minnesota Pollution Control Agency, Wisconsin Department of Natural Resources and Canadian Federal and Provincial representatives as observers.

i) presents standards which apply to waters within 1/2 mile radius from shoreline with the exception of mixing zones which will be defined by the Ministry of the Environment on an individual basis. The standards in sub-section ii) apply to waters at the 1/2 mile periphery from the shoreline. These standards are more stringent than the IJC objectives and imply considerable improvement in water quality with increasing distance from the shoreline. If the specified limits are met it is believed that restoration to near background levels should occur within a reasonable distance beyond the 1/2 mile periphery.

General standards dealing mainly with aesthetic aspects and which are applicable to both sub-sections i) and ii) are presented in Section b) of Table 4.1.

TABLE 4.1

PROPOSED WATER QUALITY STANDARDS FOR SECTIONS OF PENINSULA HARBOUR AND LAKE SUPERIOR IN THE VICINITY OF MARATHON

a) Specific Standards

Parameter	i) Waters within 1/2 mile distance from shoreline *(1)*	ii) Waters at 1/2 mile distance from shoreline
Dissolved oxygen	6 mg/l (mid-June to mid-Sept) 7 mg/l *(2)* (mid-Sept to mid-June).	9 mg/l
Turbidity	10 JTU	5.0 JTU
Phenolic substances	0.001 mg/l	0.001 mg/l
pH	6.5 - 8.5	6.5 - 8.5
Toxic substances	Toxic substances must not be added in concentrations or combinations that are toxic to human, animal or plant life *(3)*.	
Microbiological (Membrane Filter Technique) *(4)*:		
Total coliform	1,000/100 ml	1,000/100 ml
Fecal coliform	100/100 ml	100/100 ml
Fecal streptococcus	20/100 ml	20/100 ml

(1) These standards apply in all waters within 1/2 mile from shoreline with the exception of mixing zones which will be defined by Ministry of the Environment on an individual basis.

(2) The dissolved oxygen level of 7.0 mg/l is required during fish spawning periods between mid-Sept and mid-June.

(3) Refer to OWRC "Guidelines and Criteria for Water Quality Management in Ontario".

(4) The limits are expressed as geometric means based on at least 10 samples per month.

b) General Standards

i) Tainting substances - all materials that impart odour or taste to fish or edible invertebrates shall be excluded from the water at levels determined to produce tainting.

ii) Taste - all substances that will impart an objectionable taste to the water shall be excluded from the water.

iii) Odour causing materials that are not readily removable by conventional water treatment consisting of coagulation, flocculation, sedimentation, rapid sand filtration and chlorination shall not be discharged to the waters of the study area.

iv) Oil, petrochemicals or other immiscible substances that will cause visible films or toxic, noxious, or nuisance conditions shall not be discharged to the water.

v) Nutrients from unnatural sources which will stimulate the overproduction of algae, nuisance vegetation, or offensive slime growths shall not be discharged to the water.

vi) Temperature - the normal daily and seasonal temperature variations that were present before the addition of heat due to other than natural causes shall be maintained.

Heated discharges to the water will not be permitted unless it is clearly demonstrated that heated effluents will enhance the usefulness of the water resource without endangering the production and optimum maintenance of wildlife, fish and other aquatic species. It shall be the responsibility of the user to provide evidence to support the acceptability of the discharge under these terms.

Heat may not be discharged in the vicinity of spawning areas or where increased temperature might interfere with recognized movement of spawning or migrating fish populations.

vii) Settleable materials - substances shall not be added that will adversely affect the aquatic biota or will create objectionable deposits on the bottom or shore of the river.

viii) Water uses in the Marathon area should be controlled to prevent the degradation of existing high quality of Lake Superior water through the significant increase in concentration of hardness, chlorides, suspended materials, turbidity and other parameters indicative of water quality degradation.

APPENDIX A

METHODOLOGY

APPENDIX A - METHODOLOGY

A.1 MILL SURVEY

The six outfalls from the American Can of Canada Limited operations at Marathon are described in Table A.1. Triplicate samples were collected from each outfall at 1/2 hour intervals and composited over an 8-hour period between 8 a.m. and 4 p.m. on September 2 and 3, 1970. Two sets of samples were sent to the OWRC laboratory in Toronto where they were analyzed for BOD_5, solids, pH, colour, turbidity, COD, sulphate and mercury. The third set was sent to the OWRC laboratory in Thunder Bay and analyzed for phenolic substances, nutrients (nitrogen and phosphorus) and alkalinity. The samples for mercury analysis were collected in polyethylene bottles and fixed with nitric acid.

A summary of the analytical results for the 1970 survey is presented in Table B.1 (Appendix B) along with the waste loadings. A comparison of the 1970 survey data for suspended solids and BOD_5 with those obtained during the mill sampling programs conducted from 1966 to 1969, is presented in Table B.2.

A.2 WATER QUALITY SURVEY

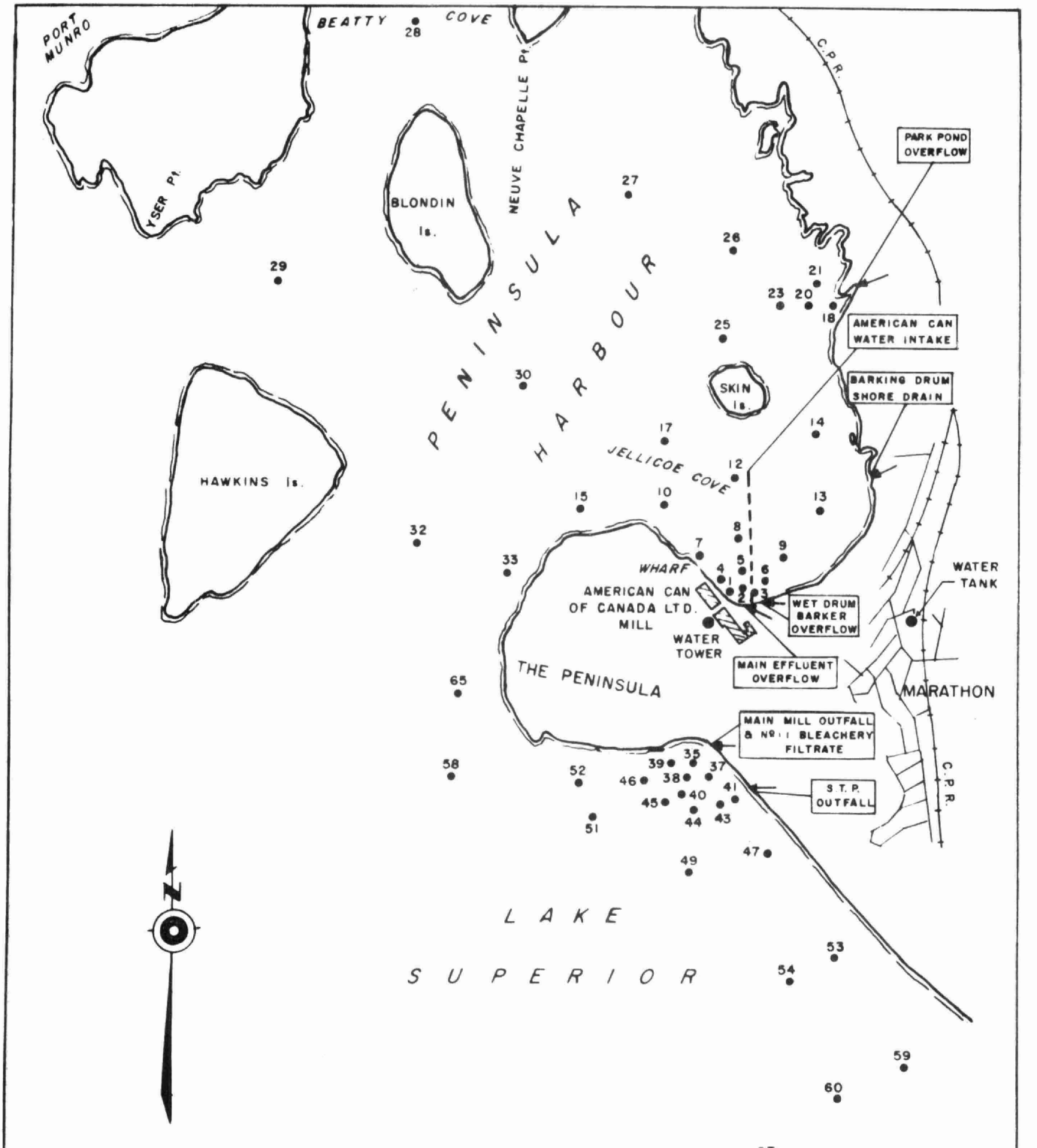
Water samples were obtained from 50 locations in the study area during the survey period between September 2 and 4, 1970. The sampling locations in Peninsula Harbour were established with the aid of the radar equipped survey vessel (Monitor II) and marked with floating buoys anchored to bottom by concrete blocks. Radar and transit measurements were also used in locating stations in Lake Superior although the locations here could not be marked with buoys due to the depth of the water and poor weather conditions. The locations of all sampling stations are shown on Figure A.1.

Two to three sets of water samples for chemical and bacteriological analyses were collected from the harbour area. Sampling of Lake Superior side was limited to the collection of one to two sets of samples due to unfavourable weather conditions. Most of the stations were sampled at the surface although a few stations were sampled at various depths to determine if changes in water quality with depth occurred.

TABLE A.1

DESCRIPTION OF OUTFALLS FROM
AMERICAN CAN OF CANADA LIMITED MILL TO LAKE SUPERIOR

Outfalls	Sources
Main Mill Sewer	Caustic room; digesters; evaporators; #1 and #2 bleachery filtrate; inside bleachery; lime kiln; bark press; green liquor dregs; machine room; part of electro-chemical plant.
No. 1 Bleachery Filtrate	Wash water after chlorine bleaching stage.
Main Effluent Sump Overflow	Overflow from main mill effluent sump and cooling water from electro-chemical plant. Operates intermittently all year.
Bark Pond Overflow	Overflow from bark settling pond that receives screened wastewaters via a spigotted pipe from the barking drums. The wastewaters from the barking drum are screened to remove large pieces of bark and this bark is then pressed and burned. Operates four to five months per year.
Wet Drum Barker Overflow	Drainage ditch and overflow from a wet drum barker that serves as a washer drum for stockpiled de-barked logs and logs directly from the log de-barking drums. Operates twelve months per year.
Barking Drum Shore Drains	Overflow water from barking drum water recycling system and springs in the area. Operates four to five months per year.



LEGEND

51 — SAMPLING STATION

ENVIRONMENT ONTARIO	
FIGURE-A:1 PENINSULA HARBOUR — LAKE SUPERIOR AMERICAN CAN OF CANADA LTD. OUTFALLS AND WATER QUALITY SAMPLING STATIONS	
SCALE : 0 1/4 1/2 MI.	
DRAWN BY : L. L. BROOME	DATE : FEBRUARY, 1972
CHECKED BY : G P	DRAWING Nº : 72-14-RB

All samples were analyzed for the same parameters as the outfall samples taken during the mill survey except the analyses for mercury were restricted to samples collected from immediate vicinities of the outfalls. Analytical results are summarized in Tables B.3 and B.4 of Appendix B.

A.3 SEDIMENT SAMPLING

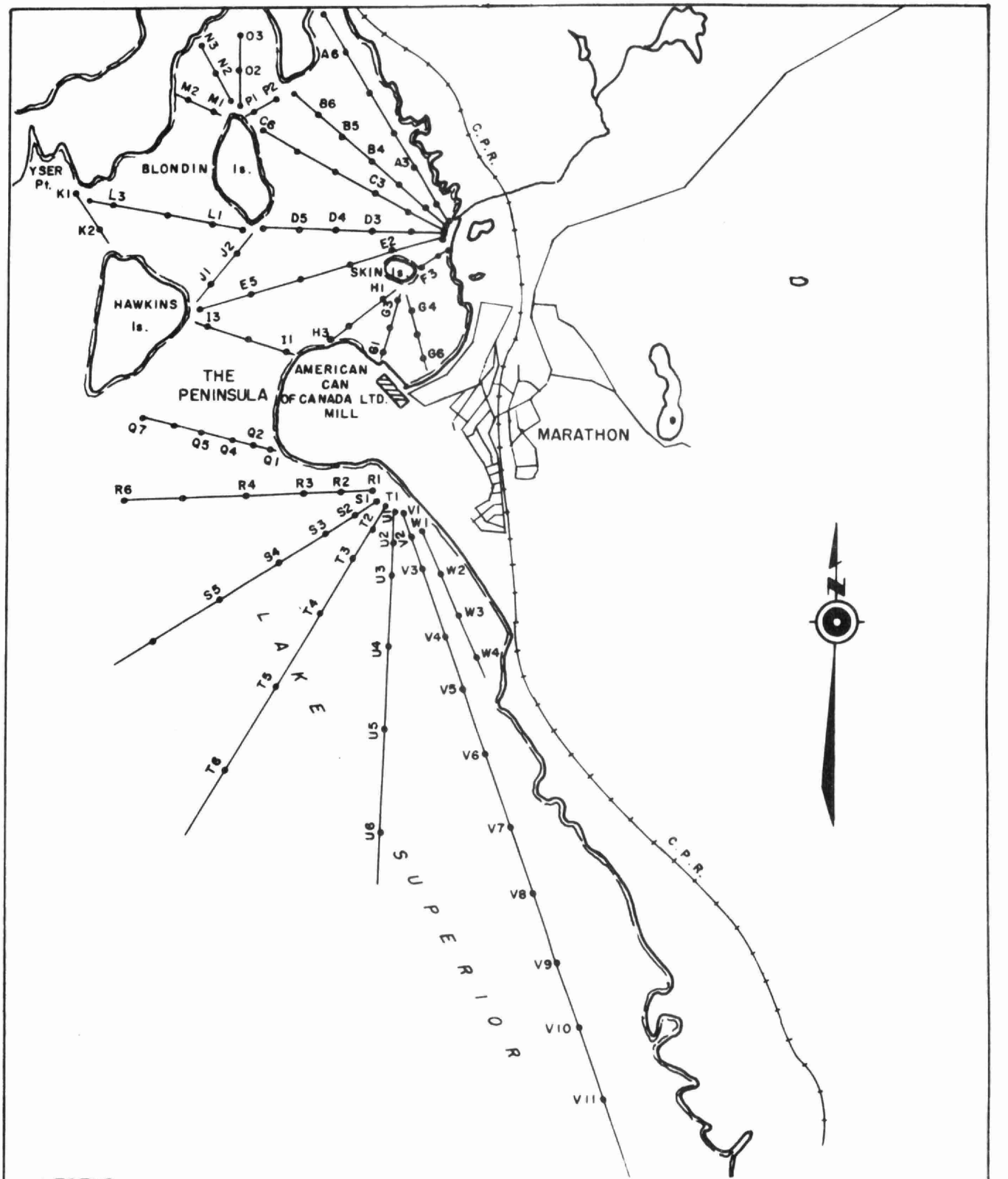
Sediment samples were collected from selected sampling stations. A Phleger core sampler was used wherever possible to obtain cores for analysis to determine the depth of mercury deposits in the sediments. Where this sampler could not be used, a piston type sampler (OWRC design) or a Ponar dredge was used.

The sediment samples were analyzed for mercury and organic material (volatile solids) content. The analytical results are presented in Table B.5 of Appendix B.

A.4 BIOLOGICAL SURVEY PROCEDURES

Standing crops of bottom fauna were examined at 109 sampling sites in Peninsula Harbour and the open waters of Lake Superior. All samples were collected during the sampling period from July 14 to 25, 1969. A complete listing of all the taxa and numbers of bottom fauna found at each sampling site is presented in Table B.6 of Appendix B. The locations of biological sampling stations are shown on Figure A.2.

The bottom fauna samples were secured with a Ponar dredge. After noting the characteristics of the sediment, the samples were washed through a 24-mesh per inch (0.0256 inch opening) sieve and organisms were separated and removed from the extraneous materials. The samples were preserved in ethanol and sent to the laboratory for subsequent identification and enumeration. In addition, several species of fish caught by Lands and Forests in 1970 in the Peninsula Harbour and nearby areas were submitted for mercury analysis. Results of these analyses are presented in Table B.7 of Appendix B.


YSER Pt.
BLONDIN Is.
HAWKINS Is.
THE PENINSULA
AMERICAN CAN OF CANADA LTD. MILL
SKIN Is.
MARATHON
C.P.R.
C.P.R.
LAKE SUPERIOR
N
LEGEND
R6 — SAMPLING STATION
ENVIRONMENT ONTARIO
FIGURE -A:2
PENINSULA HARBOUR — LAKE SUPERIOR
BIOLOGICAL SAMPLING STATIONS
1969 — SURVEY
SCALE: 0 1/2 1 1 1/2 MI.
DRAWN BY : L.L. BROOME
DATE : FEBRUARY, 1972
CHECKED BY: G.P.
DRAWING Nº : 72-15-RB

APPENDIX B

ANALYTICAL RESULTS

TABLE B.1

SUMMARY OF MILL SURVEY DATA - 1970

Outfall	Date Sept 1970	Flow MIGD	Concentrations mg/l Diss. Solids	Susp. Solids	BOD_5	Total N	Total P	Loadings lbs/day Diss. Solids	Susp. Solids	BOD_5	Total N	Total P
Main Mill	2	19.23	1,105	35	240	1.78	0.18	213,000	6,700	46,000	343	34.7
Sewer	3	13.99	910	20	300	-	-	127,000	2,800	42,000	-	-
Number One	2	3.43	1,275	5	650	0.18	0.58	44,000	170	22,300	6.0	20
Bleachery Filtrate	3	3.43	1,280	10	320	-	-	44,000	340	11,000	-	-
Main Effluent	2	1.34	330	10	26	1.03	0.12	5,600	130	350	13.8	3.6
Sump Overflow	3	6.58	910*	20*	300*	-	-	60,000*	1,320*	20,000*	-	-
Bark Pond	2	0.58	485	115	230	5.2	0.78	2,300	670	1,600	30	4.2
Overflow	3	0.79	350	170	340	-	-	2,800	1,340	2,700	-	-
Wet Drum	2	1.19	260	320	100	0.94	0.30	3,100	3,800	1,200	11.20	3.6
Barker Overflow	3	1.16	750	320	20	-	-	8,700	3,700	230	-	-
Barking Drum	2	0.34	290	80	240	1.87	0.14	1,000	270	820	44	3.3
Shore Drains	3	0.28	260	170	140	-	-	700	480	390	-	-
TOTAL	2	26						269,000	11,740	72,400	448	69.4
	3	26						243,200	10,000	76,300	-	-

* No data are available for Main Effluent Sump Overflow on September 3, 1970, dissolved solids, suspended solids and BOD_5 levels for main mill sewer on September 3 used for calculating the loading from the main mill sump overflow.

TABLE B.2

SUMMARY OF MILL SURVEY DATA 1966 to 1970

Source	Year	Flow mgd	Suspended Solids mg/l	Suspended Solids lbs/day	BOD_5 mg/l	BOD_5 lbs/day
Main Mill Sewer	1966	17.3	37	7,000	380	65,800
	1967	17.6	45	7,600	160	28,400
	1968	18.4	231	42,400	360	66,000
	1969	18.9	192	36,400	150	28,400
	1970	16.6	29	4,800	265	44,000
No. 1 Bleachery Filtrate	1966	3.8	17	600	148	5,700
	1967	3.6	10	400	14	600
	1968	3.4	18	900	235	8,000
	1969	3.4	74	2,600	235	8,000
	1970	3.4	8	200	485	16,600
Main Effluent Sump Overflow	1966	1.2	167	2,000	320	3,800
	1967	0.5	18	0	10	0
	1968	0.7	45	400	36	200
	1969	1.7	54	1,000	480	8,200
	1970	4.0	18	800	254	10,200
Bark Pond Overflow	1966	0.2	51	200	65	200
	1967	0.2	495	1,000	220	400
	1968	Nil				
	1969	0.5	174	1,000	210	1,000
	1970	0.7	146	1,000	312	2,200
Wet Drum Barker Over-flow	1966	0.2	571	1,200	61	200
	1967	0.2	93	200	50	200
	1968	0.5	298	1,400	35	200
	1969	0.6	896	5,400	340	2,000
	1970	1.2	320	3,600	59	800
Barking Drum Shore Drains	1966	Nil				
	1967	0.4	305	1,200	190	800
	1968	Nil				
	1969	0.3	484	1,600	280	800
	1970	0.3	121	400	375	600
TOTALS	1966	22.7		11,000		75,600
	1967	22.5		10,400		30,400
	1968	23.0		44,800		74,400
	1969	25.4		48,200		48,400
	1970	26.2		10,800		74,400

TABLE B.3

SUMMARY OF WATER QUALITY DATA
PENINSULA HARBOUR

Station	No. of Samples	Total Solids	Suspended Solids	Conductivity umhos/cm^2	Turbidity J.T.U.	Colour Hazen Units	Tannins	Phenolic Substances µg/l	Sulphate	BOD_5	COD
1	2	100	5	128	5.0	10	1.1	29	3	1.9	<15
2	2	85	5	103	2.0	<5	0.0	2	1	0.2	<10
3	2	90	23	105	4.0	8	0.3	6	1	0.5	<13
4	3	130	5	112	3.5	12	0.7	17	2	0.8	<10
5	3	103	5	109	2.2	17	0.5	5	1	0.9	<13
6	3	76	5	101	2.3	<5	0.1	6	1	0.5	<10
7	3	83	5	110	1.7	15	0.7	5	1	1.3	<10
8	3	80	5	102	1.5	7	0.4	4	1	0.7	<10
9	2	65	5	93	3.0	8	0.5	7	1	0.8	<10
10	1	60	5	103	3.0	5	0.0	40	1	0.6	<10
12	5	80	5	96	2.0	<5	0.0	2	1	0.6	<10
13	1	70	5	103	2.0	10	0.5	6	1	0.0	<10
14	1	70	5	102	2.0	5	0.5	6	1	1.0	<10
15	1	65	5	92	2.0	<5	0.0	2	1	0.4	<10
17	5	80	5	98	3.0	<5	0.0	3	1	0.6	<10
18	2	75	5	100	3.0	8	0.3	13	1	1.2	<10
20	2	70	5	92	2.0	<5	0.0	8	1	0.4	<10
21	1	90	5	99	<5	<5	0.0	15	1	0.6	<10
23	2	70	5	98	1.8	<5	0.1	2	1	0.6	<10
25	1	80	5	98	1.5	<5	-	3	1	0.4	<10
26	2	75	5	98	1.3	<5	0.1	6	1	0.5	<10
27	3	73	5	100	1.5	5	0.5	3	1	0.7	<10
28	1	70	5	97	3.0	<5	0.5	4	1	0.6	<10
29	1	80	5	96	3.0	<5	0.0	5	1	0.2	<10
30	4	80	5	95	2.3	5	0.0	2	1	0.4	<10
32	1	70	5	93	1.5	<5	0.0	0	1	0.2	<10
33	1	80	5	98	2.0	<5	0.4	3	1	0.8	<10

Note: Concentrations are reported in mg/l unless otherwise specified.
All values are averages of samples taken.
J.T.U. - Jackson Turbidity Units.

TABLE B.3 (cont'd)

SUMMARY OF WATER QUALITY DATA - PENINSULA HARBOUR

Station	No. of Samples	Phosphorus as P mg/l			Nitrogen as N mg/l			No. of Samples	Bacteriological (organisms/100 ml)		
		Total	Soluble	Free Ammonia	Total Kjeldahl	Nitrite	Nitrate		Fecal Coliform	Fecal Strepto-cocci	Total Coliform
1	2	0.046	0.015	0.02	0.25	0.005	0.27	1	84	572	10,100
2	2	0.014	0.006	0.02	0.23	0.004	0.33	1	8	12	384
3	2	0.025	-	0.01	0.26	0.003	0.31	1	8	40	272
4	3	0.010	0.004	0.02	0.14	0.005	0.27	2	62	260	3,300
5	3	0.012	0.005	0.02	0.20	0.006	0.26	2	68	90	7,200
6	3	0.016	0.013	0.02	0.26	0.005	0.34	2	12	44	1,008
7	3	0.008	0.004	0.02	0.11	0.005	0.26	2	44	134	1,386
8	3	0.030	0.016	0.02	0.28	0.005	0.35	1	28	24	4,600
9	2	0.008	0.006	0.02	0.08	0.005	0.35	1	<4	36	610
10	1	0.008	0.003	0.01	0.13	0.003	0.33	-	-	-	-
12	5	0.015	0.006	0.02	0.20	0.004	0.35	2	22	<4	3,450
13	1	0.011	0.003	<0.01	0.13	0.005	0.35	-	-	-	-
14	1	0.008	0.004	0.01	0.12	0.004	0.34	-	-	-	-
15	1	0.005	0.004	0.02	0.08	0.004	0.36	1	40	<4	332
17	5	0.007	0.004	0.01	0.15	0.004	0.35	4	88	6	390
18	2	0.014	0.003	0.02	0.15	0.006	0.29	-	-	-	-
20	2	0.008	0.004	0.02	0.09	0.004	0.34	1	36	28	510
21	1	0.006	0.004	0.02	0.14	0.004	0.30	1	4	24	900
23	2	0.009	0.005	0.02	0.12	0.004	0.34	1	<4	8	2,600
25	1	0.008	0.004	0.02	0.11	0.003	0.34	1	24	100	900
26	2	0.015	0.005	0.03	0.28	0.005	0.31	1	12	<4	290
27	3	0.009	0.006	0.01	0.19	0.004	0.35	3	32	8	2,000
28	1	0.013	0.003	<0.01	0.20	0.004	0.35	1	<4	28	1,400
29	1	0.005	-	0.01	0.09	0.004	0.35	1	12	16	1,000
30	4	0.016	0.009	0.02	0.20	0.004	0.36	4	24	<4	1,765
32	1	0.010	0.005	0.05	0.12	0.004	0.36	1	<4	<4	190
33	1	-	0.003	0.01	-	0.005	0.36	1	84	16	900

All values are averages of samples taken on September 2 and 3, 1970.

TABLE B.4

SUMMARY OF WATER QUALITY DATA - LAKE SUPERIOR

Station	Date Sept.	Depth (M)	Total Solids	Suspended Solids	Conductivity umhmos/cm^2	Turbidity J.T.U.	Colour Hazen Units	Tannins	Phenols ug/l	Sulphate	BOD_5	COD
35	4	T	190	5	323	-	300	20	90	-	26.0	10
37	3	B	90	5	98	3	5	0	0	1	0.4	<10
	3	T	340	10	408	4	300	24	250	7	42.0	10
	4	T	150	5	219	-	150	20	25	9	12.0	35
38	4	T	80	5	115	-	20	15	0	-	2.0	10
39	4	T	110	5	172	12	100	25	220	10	22.0	35
40	3	T	160	10	191	10.0	125	5.0	-	7	125.0	40
	3	1.5	100	5	104	2.0	10	5.5	-	1	10.0	<10
	3	3	80	5	95	1.5	<5	0.0	-	<1	<5	<10
41			70	2	104	-	15	0.6	4	<5	1.8	<10
43	3	T	80	5	96	2	<5	0.0	-	1	0.4	<10
	4	T	80	3	117	4	30	0.0	5	<5	3.0	<10
44	4	T	300	10	449	50	400	30.0	150	53	36.0	190
	4	2	50	5	94	1.5	<5	0.0	0	-	0.6	<10
	4	T	80	5	125	4.0	40	0.0	9	<5	3.5	-
	3	B	90	5	108	1.5	<5	0.0	2	<1	-	-
45	4	T	150	5	213	-	150	0.0	8	-	13.0	<10
46	3	T	90	5	110	4.0	20	1.5	8	1	3.0	10
	3	3	70	5	94	2.0	<5	0.0	-	<1	0.4	<10
	4	T	110	5	169	6.0	125	0.0	18	6	7.0	35
	4	1.5	70	3	118	4.0	30	1.6	0	3	1.8	<10
47	3	2	70	5	94	1.0	<5	0.4	4	<1	0.2	<10
	4	1	60	5	105	1.5	10	0.5	4	<5	1.4	<10
49	3	T	70	5	94	1.5	<5	-	5	<1	0.2	<10
	3	10	70	5	93	2.0	<5	-	5	<1	0.4	<10
	4	1.5	60	5	92	1.0	<5	0.4	0	2	0.4	<10
51	3	T	70	5	92	3.0	<5	0.0	0	<1	0.4	<10
	3	10	70	5	93	1.5	<5	0.0	0	1	0.4	<10
52	3	1.5	70	5	93	2.0	<5	0.0	2	<1	0.4	<10
	4	1.5	60	5	92	1.0	<5	0.0	0	-	0.4	<10
53	3	1.5	80	5	92	2.0	5	0.5	5	<1	0.2	<10
	4	3.0	70	5	101	2.0	10	0.5	3	<5	1.2	<10
54	4	1.5	70	5	97	1.0	5	0.6	12	3	1.1	<15
58	3	T	80	5	95	1.0	<5	0.0	1	<1	0.2	<10
	3	10	70	5	96	1.5	<5	0.0	0	<1	0.2	<10
59	3	1.5	80	5	92	1.0	<5	0.4	6	<1	0.2	<10

TABLE B.4 (continued)

Station	Date Sept.	Depth (M)	Total Solids	Suspended Solids	Conductivity umhmos/cm^2	Turbidity J.T.U.	Colour Hazen Units	Tannins	Phenols ug/l	Sulphate	BOD_5	COD
60	4	1.5	70	5	105	1.0	10	1.0	4	2	1.8	<10
	4	4.5	70	5	92	1.5	<5	0.0	0	1	0.6	<10
	4	10	60	5	93	1.5	<5	1.0	0	2	2.0	<10
65	3	1.5	70	5	94	2.0	<5	0.0	-	<1	0.2	<10
67	4	T	70	5	92	1.0	<5	0.0	0	2	0.4	<10
STP	4		320	20	556	20.0	100	2.4	10	17	60.0	110

Note: For stations in the outer harbour, values determined for samples collected at different depths and/or at separate times are listed separately (not averaged) since the area covered by the plume varied according to wind direction.

* 'T' and 'B' denote top and bottom samples, respectively.

Concentrations are reported in mg/l unless otherwise specified.

TABLE B.4 (continued)

SUMMARY OF WATER QUALITY DATA - LAKE SUPERIOR

Station	Date	Depth (M)*	Phosphorus as P mg/l		Nitrogen as N mg/l				Bacteriological organisms per 100 ml		
			Total	Soluble	Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Fecal Coliform	Fecal Strepto-cocci	Total Coliform
35	4	T	0.006	0.001	0.06	0.39	0.024	0.01	11,700	810	-
37	3	B	0.006	0.003	0.01	0.07	0.004	0.37	-	-	-
	3	T	0.125	0.028	0.06	0.25	0.054	0.07	9,800	920	51,000
	4	T	0.015	0.005	0.02	0.06	0.020	0.09	-	-	-
38	3	T	-	-	-	-	-	-	14,600	540	7,800
	4	B	-	-	-	-	-	-	24	0	40
	4	T	0.011	0.003	0.02	0.43	0.009	0.15	-	-	-
39	4	T	0.018	0.006	0.03	0.10	0.021	0.07	-	-	-
40	3	T	0.036	0.010	0.02	0.38	0.034	0.16	8,800	200	90,000
	3	1.5	0.008	0.002	<0.01	0.09	0.005	0.30	-	-	-
	3	3.0	0.005	0.002	0.01	0.19	0.004	0.33	-	-	-
41	4	T	0.006	0.003	0.01	0.20	0.007	0.12	-	-	-
43	3	T	0.006	0.004	0.02	0.15	0.004	0.36	8	12	70
	4	T	0.008	0.003	0.01	0.10	0.012	0.12	-	-	-
44	3	T	-	-	-	-	-	-	24	0	40
	3	B	0.005	0.003	0.01	0.14	0.003	0.36	-	-	-
	4	T	0.170	0.094	0.56	0.59	0.004	0.01	-	-	-
	4	2	0.005	0.001	0.01	0.17	0.003	0.20	-	-	-
	4	T	0.009	0.004	0.01	0.10	0.015	0.10	-	-	-
45	4	T	0.005	-	0.03	0.30	0.035	0.04	-	-	-
46	3	T	0.014	0.004	0.02	0.37	0.007	0.32	-	-	-
	3	3	0.012	0.002	0.01	0.35	0.004	0.34	-	-	-
	4	T	0.032	0.005	0.03	0.28	0.025	0.07	-	-	-
	4	1.5	0.007	0.003	0.02	0.04	0.022	0.15	-	-	-
47	3	2	0.006	0.003	0.01	0.28	0.005	0.36	<4	<4	20
	4	1	0.011	0.004	0.08	0.29	0.006	0.22	-	-	-
49	3	T	0.006	0.005	0.01	0.34	0.004	0.36	<4	8	-
	3	10	0.010	0.005	0.01	0.29	0.004	0.36	<4	<4	10
	4	1.5	0.005	0.005	0.02	0.23	0.004	0.22	-	-	-
51	3	T	0.008	0.006	<0.01	0.25	0.004	0.35	<4	<4	20
	3	10	0.004	0.003	<0.01	0.17	0.004	0.35	<4	<4	10
52	3	1.5	0.005	-	0.01	0.40	0.004	0.36	8	<4	30
	4	1.5	0.006	0.004	0.04	0.15	0.003	0.20	-	-	-
53	3	1.5	0.007	0.003	<0.01	0.20	0.004	0.36	<4	<4	<10
	4	3.0	0.009	0.003	0.02	0.08	0.009	0.22	-	-	1
54	4	1.5	0.040	0.033	0.01	0.12	0.006	0.21	-	-	-

TABLE B.4 (continued)

Station	Date	Depth (M)*	Phosphorus as P mg/l		Nitrogen as N mg/l				Bacteriological organisms per 100 ml		
			Total	Soluble	Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Fecal Coliform	Fecal Strepto-cocci	Total Coliform
58	3	T	-	0.003	0.02	-	0.004	0.36	<4	<4	-
	3	10	0.003	-	0.01	0.04	0.004	0.36	<4	<4	10
59	3	1.5	0.009	0.002	<0.01	0.07	0.003	0.36	<4	<4	10
60	4	1.5	0.007	0.003	0.02	0.09	0.004	0.21	-	-	-
	4	4.5	0.050	0.044	0.01	0.07	0.003	0.22	-	-	-
	4	10.0	0.005	0.004	0.02	0.24	0.003	0.21	-	-	-
65	3	1.5	0.005	0.003	<0.01	0.10	0.004	0.36	16	16	1,300
67	4	T	0.096	0.090	0.03	0.27	0.004	0.21	-	-	-
STP	4		4.900	-	-	22.30	0.007	0.00	-	-	-

Note: For stations in the outer harbour, values determined for samples collected at different depths and/or at separate times are listed separately (not averaged) since the area covered by the plume varied according to wind direction.

* 'T' and 'B' denote top and bottom samples respectively.

TABLE B.5

SUMMARY OF SEDIMENT DATA - MERCURY AND ORGANIC CONTENT
MERCURY LEVELS IN SEDIMENTS

Station No.	Depth of Samples* (inches)	Organic Content+ (percent)	Mercury mg/kg (Dry Weight)
1	0-3	11.8	35
	3-6	8.0	22
	6-9	7.4	1.0
	9-12	7.6	6.0
2	0-3	2.0	< 0.10
	3-5	2.0	0.29
3	0-3	5.8	11
	3-6	7.3	12
	6-9	5.4	0.6
4	0-3	44	87
	3-6	9.3	3.1
	6-9	10.0	1.0
	9-12	8.6	0.3
5	0-3	17.7	46
	3-6	14.8	96
	6-9	9.1	1.1
6	0-3	4.2	0.5
	3-6	3.7	< 0.1
	6-9	4.9	0
7	Surface		
8	0-3	12.5	37
	3-6	2.9	0.1
9	0-3	5.8	2.1
	3-6	6.6	< 0.1
	6-9	0.7	< 0.1
12	0-3	10.3	7.4
	3-6	11.6	< .1
	6-9	9.5	.15
	9-12	11.0	< 0.1
27	0-3	3.2	< 0.1
	3-6	18.9	< 0.1
28	0-3	13.3	3.5
	3-6	3.0	< 0.1
29	0-3	4.4	0.74
	3-6	3.5	0.01
30	0-3	9.8	11
	3-6	3.6	< 0.1
	6-9	2.7	0.1
44	Surface	1.1	0.12
46	Surface	1.1	0.17
47	Surface	6.8	0.41
49	Surface	1.0	0.1
51	Surface	1.1	1.5
53	Surface	1.2	< 0.1
59	Surface	1.3	< 0.1
65	Surface	6.8	3.2

* Depth below sediment surface

+ Measured as volatile solids

TABLE B.6

BOTTOM FAUNA COLLECTED FROM 109 SAMPLING POINTS
IN PENINSULA HARBOUR AND LAKE SUPERIOR
JULY 1969

STATION	DEPTH (feet)	SUBSTRATE	AMPHIPODA		ISOPODA		MULLUSCA			DIPTERA	HIRUDINEA	OLIGOCHAETA
			DECAPODA Mysis relicta	P. affinis	Gammarus	Lirceus	A.militaris	Pisidium	Sphaerium V. sincera	Tendipedidae	Erpobdellidae	Unidentified
A1	12	S		7						2		1
A2	22	S,B		17	1		4	1		11		2
A3	24	Cl		2						2		
A4	14	Cl		9		10	16			4		2
A5	20	S		26						40		4
A6	21	S		7			4			8		1
A7	12	S,Cl		2						1		
B1	20	B		2			1					2
B2	15	S,B		13	2		3			6		3
B3	22	S		17								3
B4	36	S		20						7		
B5	30	S		24						1		
B6	26	Cl		15	1			2		7		11
B7	15	Cl		7				1		20		5
C1	28	B		11	11		63			4	1	4
C2	53	B,D,S		26						10		4
C3	48	S,G		19								22
C4	48	S,Cl		43						3		8
C5	54	S,B,F		3	18		36			10	3	3
C6	50	M,B,F		14	82		120	2		3	3	20
D1	20	B					7	1		40		109
D2	34	B		18	1		15	1		7		2
D3	48	Cl		15						1		
D4	54	S,Cl		86				1		1		10
D5	60	S,B		31	8		6			8		50
D6	75	S,Cl		69			2					7
E1	19	B		15	8		9	3		34		29
E2	28	B,S,Cl		7	1		2			10		18
E3	18	B		10						24		
E4	90	S		121				3		3		35
E5	135	Cl,D		118			8			12		100
E6	105	S,Cl		143			1			8		18

TABLE B.6 (continued)

STATION	DEPTH (feet)	SUBSTRATE	DECAPODA	AMPHIPODA		ISOPODA	MULLUSCA			DIPTERA	HIRUDINEA	OLIGOCHAETA
			Mysis relicta	P. affinis	Gammarus	Lirceus	A.militaris	Pisidium	Sphaerium	V. sincera	Tendipedidae	Erpobdellidae	Unidentified
F1	55	S,B									11		55
F2	22	B			2		89	2			17		22
F3	6	M,B		20	6		12				56		6
G1	45	M,B		100			16	36			5		132
G2	48	M,Cl,B		10			7	30			23		573
G3	22	Cl		19			1				1		27
G4	42	M,Cl,B		82	6		14	13			13		88
G5	30	M,Cl,B		37			32	13			2		36
G6	20	M,Cl,B		2							1		712
H1	32	S	1	67				2			5		94
H2	85	M,Cl,B		90	4		5	1			2		1705
H3	55	M,Cl,B	1	189			12	5			15		67
I1	140	Cl,B,F		95			5	1			4		302
I2	180	Cl		153	2						6		36
I3	160	Cl		214				13			2		43
J1	120			181	3						12		43
J2	130			127							10		70
K1	75	S,Cl		11							2		13
K2	70	S		37									1
L1	95	Cl		102							11		5
L2	105	Cl		87				3			15		29
L3	75	Cl		19	5								
M1	82	Cl		126	18		20	3		2	15		49
M2	75	Cl		66	3		2	6		1	21		36
N1	62	Cl		63	2		1				2		21
N2	70	Cl		51	4			9			65		42
N3	77	Cl		73	2		4	8			19		47

TABLE B.6 (continued)

STATION	DEPTH (Feet)	SUBSTRATE	DECAPODA Mysis relicta	AMPHIPODA P. affinis	AMPHIPODA Gammarus	ISOPODA Lirceus	ISOPODA A. militaris	MULLUSCA Pisidium	MULLUSCA Sphaerium	MULLUSCA V. sincera	DIPTERA Tendipedidae	HIRUDINEA Erpobdellidae	OLIGOCHAETA Unidentified
O1	65	Cl,B,F		95	15		2	5	1		1		78
O2	63	Cl		76	2		12	4		1	24		
O3	56	Cl		6	5		55	3				1	29
P1	60	Cl		106	9		21	3			13		98
P2	20	S		20				28			7		71
Q1	222	M,Cl,B, F		260				3			7		26
Q2	210	M,Cl,B, F		155	3						3		73
Q3	210	M,Cl,B, F		185			2	7			5		154
Q4	200	M,Cl,B, F		177	7						3		181
Q5	180	M,Cl,B, F		50	2						1		248
Q6	168	M,S		123							2		137
R1	2	S,F		7									
R2	4	S,F		8									
R3	45	S	1	15							1		
R4	150	S		108				8			3		101
R5	200	M,Cl		140				8			1		178
R6	235	M,Cl		96				2					70
S1	8	S		11									5
S2	10	S											1
S3	34	S		7							2		
S4	85	S		29				2			6		142
S5	150	S,Cl		81				11					150
S6	235	Cl		187							3		97
T1	8	S											
T2	18	S		2							1		
T3	43	S		12							9		7
T4	50	S		25									6

TABLE B.6 (continued)

STATION	DEPTH (feet)	SUBSTRATE	DECAPODA	AMPHIPODA		ISOPODA		MULLUSCA			DIPTERA	HIRUDINEA	OLIGOCHAETA
			Mysis relicta	P. affinis	Gammarus	Lirceus	A.militaris	Pisidium	Sphaerium	V. sincera	Tendipedidae	Erpobdellidae	Unidentified
T5	120	S	1	70				10			1		33
T6	220	Cl		38				11					8
U1	8	S		18				1			1		2
U2	20	S		3									
U3	45	S		11									
U4	60	S		5							1		
U5	60	S,G		1									
U6	80	S									2		6
V1	6	S		4									
V2	17	S		7							2		
V3	30	S		7									1
V4	30	S		7									
V5	45	G		2									12
V6	25	S		1									
V7	45	G											
V8	33	G											1
V9	45	S,Cl		6	1						4		
V10	65	S		22							1		4
V11	65	S		26							1		
W1	2	S											1
W2	2	S		1									
W3	4	S		5									
W4	4	S		1									

TABLE B.7

MERCURY LEVELS IN FISH FROM LAKE SUPERIOR IN THE VICINITY OF MARATHON

LOCATION	SPECIES	MERCURY mg/kg (Wet Weight)
Manitoba Shoal	Lake trout	0.70
	Lake trout	8.0
	Whitefish	1.3
	Whitefish	1.0
	Cisco	0.39
	Cisco	0.41
	Smelt	0.18
Red Sucker Cove	Lake trout	3.3
McKay Rocks	Whitefish	0.15
	Cisco	0.21
	Cisco	0.35
Ypres Point	Lake trout	0.70
Randle Point	Cisco	0.24
	Cisco	0.24
	Cisco	0.27
	Cisco	0.40
	Cisco	0.29
	Cisco	0.25
	Whitefish	0.15

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Ministry of Environment

ENVIRONMENTAL QUALITY OF PENINSULA HARBOUR LAKE SUPERIOR, 1972

TERMINAL STREAM: SUPERIOR L.

DATE	ISSUED TO

DATE	ISSUED TO